THREE DIMENSIONAL RECONSTRUCTION OF MAXILLA USING FREE FIBULA FLAP

Dissertation submitted in partial fulfilment of the requirements for the degree of

M.Ch. (Plastic & Reconstructive Surgery) – Branch III

THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY

CHENNAI

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CERTIFICATE

This is to certify that **DR. C. PRABAKAR,** *post graduate (2010-2013) in the Department of Plastic, Reconstructive & Faciomaxillary Surgery, Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai-03, has done dissertation titled,* **"THREE DIMENSIONAL RECONSTRUCTION OF MAXILLA USING FREE FIBULA FLAP",** *under my direct guidance and supervision in partial fulfilment of the regulations laid down by* **THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY, GUINDY, CHENNAI-32** *for the degree of* **MASTER OF CHIRURGERY**, *plastic & reconstructive surgery (branch III) degree examination.*

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DECLARATION

I solemnly declare that this dissertation **"THREE DIMENSIONAL RECONSTRUCTION OF MAXILLA USING FREE FIBULA FLAP"** was prepared by me in the Department of Plastic, Reconstructive and Faciomaxillary Surgery, Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai between 2010 and 2013.

This dissertation is submitted to **THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY, CHENNAI** in partial fulfilment of the university requirements for the award of degree of **MCh PLASTIC & RECONSTRUCTIVE SURGERY**.

Place: Chennai **Signature of the Candidate**

Date:

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CONTENTS

Introduction

Maxilla forms the keystone in the bony architecture of the midface. It also contributes significantly to mastigation, deglutition, speech, nasal function, support of globe and its orbital contents and most importantly towards the facial aesthesis.

Maxillary defects may occur primarily following resections for odontogenic or non odontogenic tumours of the maxilla or as secondary maxillary defects following treatment of facial trauma and infection. They produce significant morbidity to the patient by not only affecting the appearance and structural integrity of the facial skeleton but also by causing functional deficits in swallowing, speech, taste and vision[1].

Maxillary defect reconstruction creates both functional as well as aesthetic challenge for a surgeon. The goals of reconstruction must include, like tissue replacement, barrier creation between nasal and oral cavities, reconstruction of maxillary architecture and the restoration of the structural integrity of midface. The reconstructed maxilla will act as a scaffold for the soft tissue of the face to suspend and finally with restoration of dentition, return of mastigatory function can be achieved.

The available options for maxillary defect reconstruction are use of obturator, local flap, pedicled flap and free flap.

Traditionally maxillary defects were obturated by bulky dental prosthesis. Although reasonably acceptable results can be achieved in most of the cases, yet many patients who were using it became dissatisfied for many reasons. The obturator should be retentive enough to aid in swallowing, speech, mastigation and cosmetic appearance and in avoiding oro-nasal regurgitation. Maintenance of adequate hygiene around the prosthesis needs excellent patient compliance with the prosthesis[2].

Local and pedicled flaps for maxillary reconstruction always fall short of the requirements needed and invariably add to the morbidity of the patient.

Reconstruction of maxillary defects by osseocutaneous flaps using micro vascular anastomosis followed by osseointegrated implants is one of the significant improvements in head and neck reconstruction in the recent past.

McLean and Buncke in 1969 did the first ever free tissue transfer using microvascular anastomosis by reconstructing a scalp defect with a free omental flap. Later Daniel and Taylor[3] in 1973 did free groin flap for lower extremity reconstruction. Use of microvascular anastomosis for reconstruction of mandibular defects was first introduced by Hidalgo[4] in 1989. Sadove[2] and his colleagues in 1993 did the simultaneous reconstruction of maxillary and mandibular defects using free fibula osseocutaneous flap.

There are many advantages of free fibula flap compared to obturation or use of either local or pedicled flaps. Its ability to provide skin, muscle and bone as a composite unit, provision of soft tissue bulk which could fill in the defects, the freedom of orientation of the flap so that it can easily be tailored to the defect and the ability to three dimensionally reconstruct the maxillary defect in a single stage makes it the best reconstructive option for maxillary defects.

Aim of study

To evaluate free fibula flap as a suitable tool for maxillary defect reconstruction

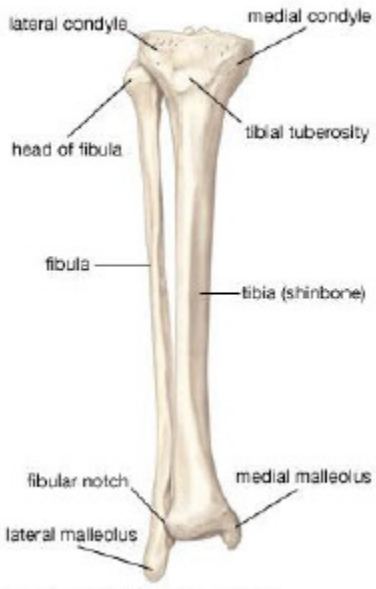
To assess the functional and aesthetic outcomes after maxilla reconstruction using free fibula flap

Evaluation of the long term outcome takes into account the following

1. Overall patient's satisfaction with the surgery
2. Functional improvement in terms of speech quality, mastigatory capability, nasal breathing efficiency and presence of nasal regurgitation
3. Cosmetic improvement using visual analogue score.
4. Complications after surgery
5. Donor site morbidity.

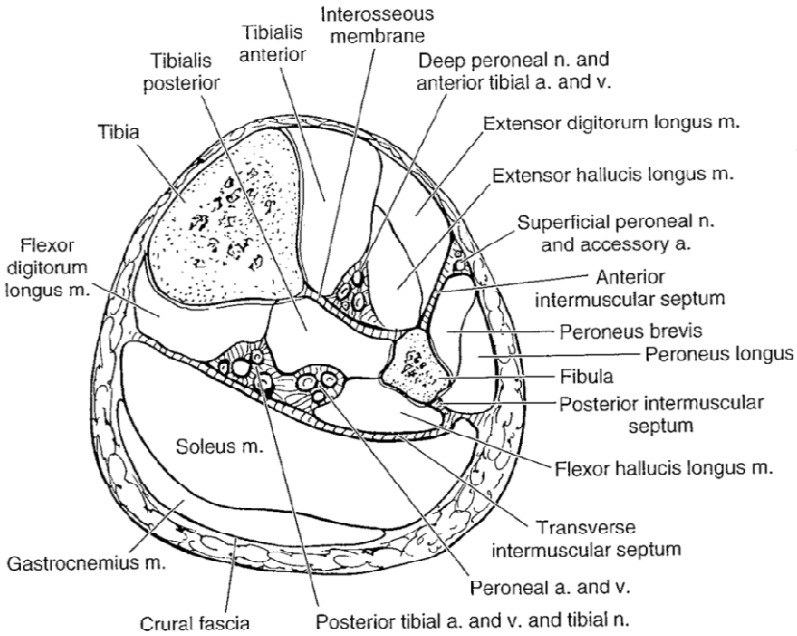
Surgical anatomy

Fibula is a cortical bone that doesn't participate in weight bearing. Almost the entire length of the fibula can be harvested leaving behind 6 to 7cms of bone both proximally and distally, so that the integrity of the knee and ankle joints is preserved. Raised on a vascular pedicle that contains the peroneal artery and its venae comitantes, it can provide a maximum of 30cms of free vascularised bone graft in tallest of individuals.



Attached to tibia both at its proximal and distal end, the shaft of fibula has three borders: anterior, inter-osseous and posterior. The anterior and inter-osseous borders are located on the lateral and medial surface while the posterior border which is usually less distinct is directed posteriorly. The anterior border gives attachment to the anterior intermuscular septum, the inter-osseous border gives attachment to the interosseous membrane and the

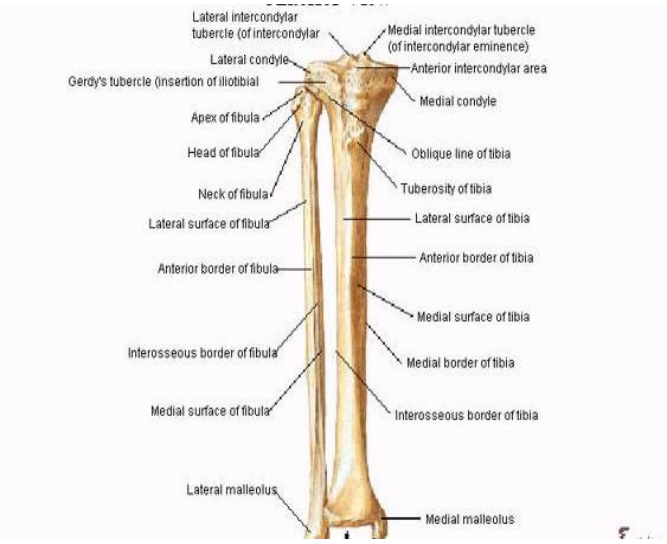
posterior border gives attachment to the posterior intermuscular septum respectively.



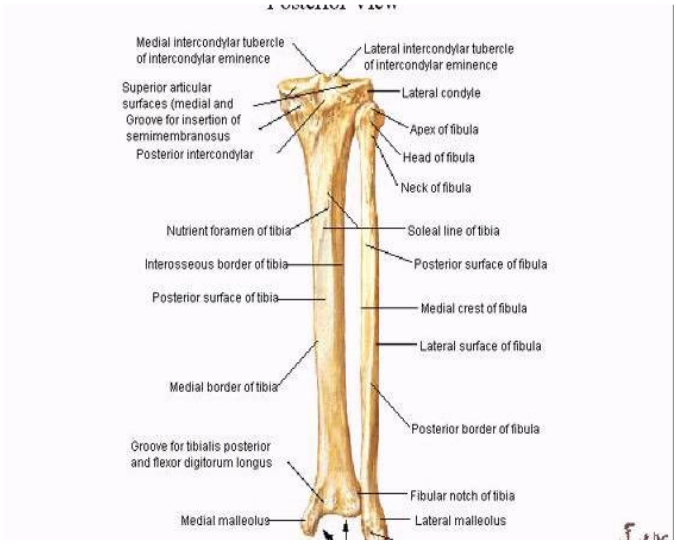
The interosseous membrane separates the anterior and deep posterior compartments of leg and gives origin to muscles in both the compartments.

Muscle attachments

Anterior view

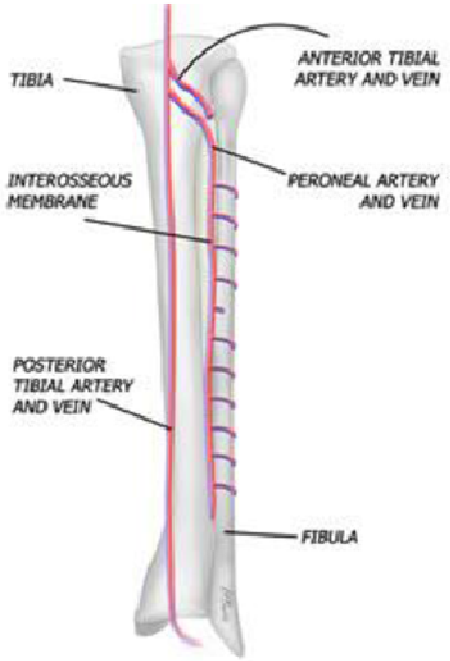


Posterior view



It has three surfaces lateral, medial and posterior. Totally nine muscles get attached to fibula of which only the Biceps femoris pull the fibula upwards whilst the rest pull it downwards. The lateral surface gives origin to peroneous longus and peroneous brevis. The Peroneous longus takes origin from the upper two-thirds of fibula and the Peroneous brevis from lower two-thirds. The medial surface gives attachment to Extensor digitorum, Extensor hallucis longus and Peroneous tertius muscles. They occupy the extensor compartment. The Soleus, Tibialis posterior and the Flexor hallucis longus takes origin from the posterior surface of the fibula. The Tibialis posterior is the deepest muscle in the posterior compartment. Lying between the Flexor digitorum longus and Flexor hallucis longus it takes origin from tibia, fibula and the interosseous membrane. The Flexor hallucis longus takes origin from the lower two-thirds of the posterior surface of fibula, the transverse intermuscular septum as well as the interosseous membrane.

Blood supply



The Peroneal artery stems from posterior tibial artery 3-4cms distal to the origin of anterior tibial artery and follows a course parallel to fibula lying between the flexor hallucis longus and tibialis posterior or within the substance of flexor hallucis longus. All along its course lying posterior to fibula it gives off multiple arcuate arteries that send periosteal blood supply to fibula and then perforate the muscles to supply the skin of the posterolateral aspect of leg, emerging along the posterolateral septum. At about the mid-point of fibula the bone also gets the endosteal blood supply from the nutrient artery entering the nutrient foramen. Thus the middle third of the fibula has the richest blood supply suitable for harvest.

The artery terminates distally, below the lateral malleolus to become the lateral calcaneal artery. At its origin the diameter of the peroneal artery is 1.5-2.5mm and the pedicle length is 4-6cms. It has two accompanying venae comitantes with an external diameter of approximately 2-4mm.

Review of literature

Classification of maxillectomy defects

Aramany M[5] in 1978 divided maxilla defects into six types.

Class I - defect did not cross the midline and preserved the teeth on the contralateral side of the maxillary arch.

Class II - defects were more limited, with preservation of the contralateral maxillary teeth, the central incisors, and, if possible, the canines and premolars on the resection side.

Class III - defects involved only the central hard palate, without resection of any teeth.

Class IV - defects crossed the midline, preserving only the posterior teeth on the contralateral side.

Class V - defects involved resections of the posterior portion of the maxillary arch, with preservation of the mesial abutment teeth on both sides.

Class VI - defects involved resection of the midline central maxilla, with preservation of the teeth posterior to those used for abutment.

James S. Brown, Simon N. Rogers et al[6] in 2000 made a classification system based on the review of forty five consecutive maxillectomy cases which were obtained from the database (September 1992) and another retrospective study from 1989. They came out with a useful classification

system which could correlate the likely aesthetic and functional outcomes after maxillectomy with that of the method of rehabilitation.

The classification of the vertical component is as follows:

Class 1- maxillectomy without an oro-antral fistula

Class 2- low maxillectomy (not including orbital floor or contents)

Class 3- high maxillectomy (involving orbital contents) and

Class 4-radical maxillectomy (includes orbital exenteration)

The horizontal or palatal component is classified as follows:

a- Unilateral alveolar maxillectomy

b- Bilateral alveolar maxillectomy and

c- Total alveolar maxillary resection.

Okay et al[7] in 2001 proposed a maxillectomy defect classification system with a view toward the assessment of functional outcome, prosthetic retention, and patient satisfaction.

Class IA: no involvement of the tooth-bearing alveolus.

Class IB: preservation of both canines.

Class II: resection of one canine or less than 50% of the hard palate

Class III: resection of either canines or greater than 50% of the hard palate.

Subclass f: involvement of the orbital floor.

Subclass z: involvement of the zygomatic arch

James S Brown and Richard J Shaw[8] in 2010 brought about a classification system that was entirely based on the already published systems of classification. The system also incorporates the midface into its classification schemes. They showed two types of classification.

Vertical classification:

I—maxillectomy not causing an oronasal fistula;

II—not involving the orbit

III—involving the orbital adnexae with orbital retention

IV—with orbital enucleation or exenteration;

V—orbitomaxillary defect

VI—nasomaxillary defect.

Horizontal classification:

a - Palatal defect only, not involving the dental alveolus

b- Less than or equal to 1/2 unilateral;

c- Less than or equal to 1/2 bilateral or transverse anterior;

d- Greater than 1/2 maxillectomy.

Avinash S. Bidra, Rhonda F. Jacob et al[9] in 2012 have classified maxillectomy based on six criteria which satisfied both the surgical and prosthetic needs. They concluded that description based on set criteria appears to be more objective and amenable for universal use than a description which is classification based.

Anatomical variations

S. W. Choi et al[10]in 2001 did a cadaveric study of 63 legs of Korean cadavers and demonstrated that it is the area between the middle and lower thirds of fibula where most of the musculoperiosteal and septocutaneous perforators of the peroneal artery were liable to be concentrated. The ratio of musculoperiosteal perforators to the skin to that of the musculoperiosteal branches were usually 2:1.

W.H. Wang et al[11]in 2011 did a study to investigate the added value of preoperative computerized tomography angiography (CTA) and three-dimensional reconstruction of the lower limb in vascularised fibular flap transfer and concluded that the course of peroneal artery is relatively invariable and its original external diameter was usually thick.

Methods of maxillary defect reconstruction

Yadranko Ducic[12] in 2001 reported the use of thermoplastic polymer for temporary obturation for maxillectomy defects.

Brian L. Schmidt et al in 2004 reported the use of zygomatic implants for reconstruction of extensive maxillectomy defects.

Masayuki Fukuda et al[13] in 2004 and Claudio Rodriguez Leles et al in 2009reported the use of implant supported obturator.

Sekou Singare et al in 2007[14]reported case reports of maxillary defects reconstructed with prefabricated titanium mesh prosthesis fabricated using rapid prototyping.

Pravinkumar G. Patil[15] **in 2011** reported simple technique to fabricate an immediate surgical obturator by restoring the patient's original dentition and facial and palatal tissue form.

T.V. Padmanabhan et al[16] **in 2011** reported rehabilitation of a maxillectomy with a two-piece hollow bulb obturator in which they have used magnetic retention.

Reconstruction of maxillary defects by microvascular technique

H. A. H. Winters et al[17] **in 2003**used a horizontally placed deep circumflex iliac artery free flap with internal oblique muscle in four patients for maxillary reconstruction and concluded that this is a reliable method, the flap is easy to harvest, and the donor site morbidity is minimized by using only the inner table of the iliac crest.

S. Duflo[18] **et al in 2005** analyzed the quality of life in 30 cases of palatal defects were reconstructed using micro vascular radial forearm fasciocutaneous free flap and reported that radial forearm fasciocutaneous free flap for palate reconstruction is a versatile technique which provides adequate

separation between oral and sinonasal cavities and the quality of life is also enhanced with good quality speech recovery, ability to swallow and also mastigation. They stated that it has to be considered an essential component of head and neck cancer therapy and rehabilitation.

R. González-Garcia[19] et al in 2007 reported fifty-five patients who underwent reconstruction by means of the radial forearm free flap after resection for squamous cell carcinoma of the oral cavity and the results revealed that the radial forearm free flap is a reliable method for reconstructing a wide range of oral cavity defects with an acceptable low morbidity rate. It provides adequate bulkiness and pliability, resulting in adequate reconstruction of a wide variety of defects within the oral cavity

Kemal Ugurlu[20] et al in 2007 reported nine cases that had composite palatomaxillary defects which were reconstructed with free angular scapular bone flap combined with serratus anterior fascia with sub scapular vascular system as the vascular pedicle in the years between 1999 and 2003. They concluded that the chimeric flap of this dimension combining scapular bone, serratus anterior muscle with its fascia and the large skin paddle all with the sub scapular artery as the vascular pedicle has unmatchable advantages over others, in the form of convenience of combining different tissue compositions and providing all the elements needed for palatomaxillary reconstruction.

Matthew M. Hanasono[21] et al in 2008 reviewed 39 patients who were treated with multiple simultaneous free flaps for head and neck reconstruction between 2001 and 2007 and they concluded that multiple simultaneous free flaps can be performed safely in patients, with acceptable recovery times and functional outcomes. In select cases, the authors advocate multiple free flap reconstruction to maximize quality of life even in patients with advanced cancers.

Deepak Kademani[22] et al in 2009reported reconstruction of maxillary defect with medial femoral periosteal micro vascular free flap. They stated that the medial femoral condyle corticoperiosteal flap results in a limited donor defect because it provides a vascularised periosteum in addition to cortical and cancellous bone and it provides an excellent option for the treatment of limited composite defects of the maxilla, with minimal donor-site morbidity.

Amresh S. Baliarsing[23] in 2010reported8 cases of maxillary reconstruction using deep circumflex iliac artery–based composite free flap. They reported that the contour of the iliac bone is similar to the maxilla and provides good aesthetic result. They also added that deep circumflex iliac artery flap is difficult to harvest, has variable anatomy, and needs meticulous planning for optimum result.

Thomas Mücke et al[24] in 2011 reported eighty three cases, having different types of post maxillectomy defects. All were reconstructed with different free flaps which included radial forearm flap, anterolateral thigh flap, latissimus dorsi myocutaneous flap, deep inferior epigastric artery flap and free fibula flap. They concluded that it requires a very steep learning curve for reconstruction of these defects, because of the complex anatomy and the necessity of achieving both form as well as functional restoration.

Osseocutaneous free fibula flap reconstruction

Xin Peng et al[25] in 2005 reviewed thirty-four consecutive cases of maxillary reconstruction with the free fibula flap and they concluded that alveolar arch defects are best suited for reconstruction using free fibula flaps and it has a very good success rate with a low perioperative complication rate, which makes it a comfortable choice for maxillary defect reconstruction.

D. David Kim et al[26]in 2007 reported that free fibula flap has many advantages like, the ability to harvest bone, muscle, and skin simultaneously is beneficial in reconstructing the complex anatomy of the maxilla. Multiple skin paddles can be obtained to line the orbit and separate the oral and nasal cavities. The excellent periosteal blood supply allows multiple osteotomies that facilitate re-establishing the anatomic contours of the maxilla.

Shah ram Nazarene et al[27] in 2008 reported 11 cases of maxillary reconstruction with the prefabricated free fibula flapbetween1994 to 2005 and they stated that the prefabrication of fibula by means of banking the prosthetic materials in the leg until the flap gets matured was a better choice compared to other methods which uses fibula for maxillary reconstruction.

Yue He et al[28] in 2009 reported reconstruction of composite total maxillectomy defects with fibula osteomyocutaneous flap flow-through from radial forearm flap and concluded that the fibula osteomyocutaneous flap is an ideal donor site in 3D total maxillectomy defect reconstruction, because of its thickness, length, and bone uniformity which makes ideal support for dental rehabilitation.

Jian Sun et al[29] in 2011 reviewed twenty patients who had suprastructure maxillectomy followed by reconstruction of the defect using composite free fibula flap plus titanium mesh and other implant materials. They concluded that the procedure is an easy and genuine one, having a very good success rate with very less adverse effects; it can produce satisfactory aesthetic results as well as good return of function.

Eric Santamaria et al[30] in 2012 reported 14 patients who had prelaminated osseocutaneous fibula flap for maxillary reconstruction in a two stage surgery and stated that prelamination delivers like tissue to the recipient site, obviates the need for debulking, and may reduce donor-site wound problems.

Surgical planning

Andre Eckardt and KonstantinosFokas[31] in 2003 reviewed 500 cases of micro vascular reconstruction and reported that it is preferable to do simultaneous reconstruction after a wide local excision of the tumour as compared to that of delayed secondary reconstruction.

Horst Kokemueller et al[32] in 2008 reported that patients with total loss of the maxilla including the orbital floor and preservation of orbital contents, primary reconstruction of orbital and zygomatic contours with individualized titanium implants using computer-assisted techniques in combination with simultaneous transplantation of free soft tissue flaps for vitalized defect refilling provides good functional and aesthetic results with predictable outcome.

Shu-Ying Chang et al[33] in 2010 reviewed 116 free fibula cases based on ischemia time and concluded that if the warm ischemia time is below five hours for a free fibula flap based reconstruction of head and neck defects. There is no significant differences noted in the rate of complications developed

among different cases done and so it has been stated that the ischemia time for free fibula flap is less than five hours in case of head and neck reconstruction surgeries to reduced skin paddle loss or other complications.

W.H. Wang et al[34] in 2011 reported that preoperative Computerized Tomographic Angiography and three-dimensional reconstruction of the lower limb, which are non-invasive, accurate and direct-viewing methods, play an important, preoperative role in vascularised fibular flap transfer for lower limb vascular assessment.

Patrick B. Garvey et al[35] in 2012 did preoperative computed Tomographic angiography scanning of the peroneal artery and its perforators and concluded that Computed Tomographic Angiography accurately predicted the anatomy and location of the peroneal artery and perforators and also provides valuable information to facilitate osseocutaneous fibula flap harvest.

Tao Zhang et al[36] 2012 reviewed 178 micro vascular surgeries in which venous anastomosis was compared with anastomotic coupler device and hand sewing technique and reported that the micro vascular coupler is useful for venous anastomosis in free flap head and neck reconstruction; double venous anastomosis appear to be better than isolated venous anastomosis.

Complications

Andre Eckardt and Konstantinos Fokas[37] in 2003 reported a review of 500 cases of micro vascular reconstruction. They found out that the significant contributing factors for the development of both medical as well as surgical complications were smoking and prolonged anaesthesia time (>8 hrs).

Eric M. Genden et al[38] in 2004 has said that complications of micro vascular free tissue transfer can occur both at the recipient site and at the donor site. Recipient site complications are mainly due to the result of thrombus formation at the microvascular repair site, where as a lot of factors can contribute to the formation of donor site complications. Like the onset of infection and the sequelae of flap harvest. Moreover, it has been stated, that the risk of producing distal extremity ischemia after the flap harvest was found to be most significant for both the free radial forearm flap and free fibula flap. Hence it becomes necessary to document collateral circulation in them before venturing into harvesting these flaps.

Alan Garrett, Yadranko Ducic et al[39] in 2006 evaluated foot and ankle function in a series of patients undergone fibula micro vascular free tissue transfer. They came with the results using the ankle-hind foot scale and follow-up radiographs which support a low morbidity rate at the donor site after free fibula graft harvest.

Philipp Pohlenz et al[40] in 2007retrospectively analyzed 202 cases of micro vascular reconstruction of head and neck and they confirmed that the microvascular reconstructions using free fibula flap are capable of producing the most reliable and significant method of reconstruction in head and neck region. The complication rate is directly proportional to the preoperative co morbid factors.

Adeyiza O. Momoh, Peirong Yu et al in 2011 showed donor site morbidity in 157 patients treated with free fibula flap .They showed that perioperative donor-site complications occurred in 31.2 percent of patients, including skin graft loss (15 percent), cellulitis (10 percent), wound dehiscence (8 percent), and abscess (1 percent). Preoperative chemotherapy was associated with increased complications. No significant difference in complication rates was observed between primary and skin graft wound closure. The timing of ambulation was not related to the development of complications. Long-term morbidities occurred in 17 percent of patients and included leg weakness (8 percent), ankle instability (4 percent), great toe contracture (9 percent), and decreased ankle mobility (12 percent).

P. Pohlenz et al in 2012 did a study in which they analyzed outcome and complications of free flaps in 1000 cases. They did 120 free fibula reconstructions out of 1000 cases. They concluded that venous thrombosis and cervical hematoma are the most common complications at the recipient site and are mainly responsible for flap failure, while complications occurring at the donor site may result from dehiscence and graft necrosis. When a compromised flap is identified, surgical re-exploration should not be deferred.

Materials and methods

Subject selection:

This study incorporates 6 patients with either primary maxillary pathology in the form of malignancy (low grade), osteomyelitis or benign maxillary diseases needing infra structure maxillectomy in young healthy individuals and also those patients with existing maxillary defects following facial trauma. All the patients who reported to outpatient block of Department of Plastic Surgery at Madras Medical College / RGGGH who satisfied the following criteria were included in the study.

Inclusion criteria:

Patients with primary maxillary tumours benign/low grade malignant requiring partial/total maxillectomy.

Patients with osteomyelitis of maxilla requiring maxillectomy.

Patients with maxillary defects secondary to trauma.

Patients who had no medical contraindications for surgery.

Patients who are willing to have regular follow up.

Exclusion criteria:

High risk individuals who are medically unfit

Patients with generalized disorders of bone

Patients who are not willing for long term follow up

Elderly patients.

Preoperative assessment

This included a detailed history taking, thorough physical examination, facial photography and radiological evaluation.

History taking regarding the nature of illness, chief complaints, duration of present illness, previous surgical interventions done, any co morbid illness precluding major surgical procedures as well as their occupation and habits were obtained.

Clinical examination was done in all cases to determine the overall general condition, nutritional status, level of intelligence and willingness to undergo the procedure.

Recipient site examination included extra oral assessment for facial asymmetry, mouth opening, speech disturbances and intra oral assessment to

determine the site, size and extent of defect/lesion, occlusion status and presence of oro-nasal communication.

Donor site was assessed for presence of palpable pulsation in all the three major vessels of the leg (peroneal and anterior and posterior tibial vessels), presence of pre existing gait disturbances in the limb, venous insufficiencies and any scars or cutaneous lesions.

Radiological evaluation was performed by taking the following investigations

1. Orthopantomogram
2. X-ray PNS
3. CT facial bones with 3D reconstruction
4. X-ray of leg with both ankle & knee joints.
5. Duplex USG assessment of both arterial & venous system in the leg.

Totally 6 male patients were included in this study. Two patients had squamous cell carcinoma of maxilla requiring maxilla resection which resulted in class II c type of modified Brown's classification of maxillectomy defects. Two patients who had post traumatic maxillary defect both on the left side maxillary arch requiring maxilla reconstruction belonging to class II a type of modified brown's classification of maxillectomy defects, one patient was secondarily reconstructed for a maxillectomy defect due to treated mucormycosis of left maxilla also belong to class II a type of modified

brown's classification of maxillectomy defects and another patient had benign odontogenic cyst of maxilla that require segmental maxillectomy also belonging to class II a type of modified brown's classification of maxillectomy defects.

All the six patients were clinically examined and preoperative Doppler study using an 8 Hz hand held Doppler device was done to rule out any vascular abnormalities both at recipient and donor sites. None of these patients showed inadequate collateral blood circulation or any other abnormalities. In the leg Doppler study was done especially to rule out the possibility of peroneal artery dominance for the leg and if it was so, then the case would be rejected. But all our cases had no peroneal artery dominance and hence proceeded with free fibula harvest.

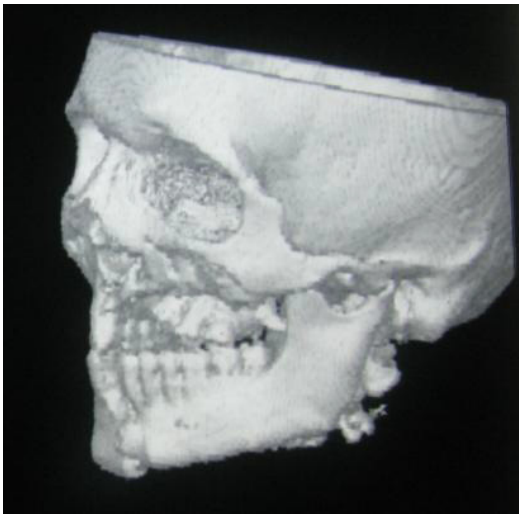
All the six patients underwent preoperative CT facial bones with 3D reconstruction in order to determine the extent of maxillary resection needed, thereby to estimate the amount of fibula that will be required for reconstruction.

Preoperative planning is done exquisitely using impression models for both maxilla and mandible which were made up of dental compound, models were mounted on articulators and after aligning them in class I occlusion the preferred site of osteotomies on the maxilla and the also the necessary arch

alignment adjustment required to produce a class I occlusion were determined. Thereby the actual defect was easily identified and the appropriate site of screw fixation of the fibula graft on the surrounding bone was precisely understood. This will provide the ideal facial contour with normal occlusion after reconstruction.

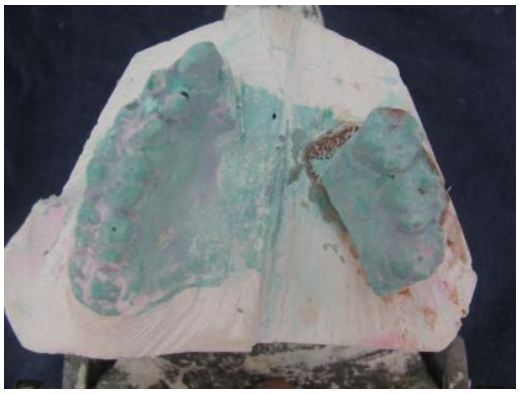
PREOPERATIVE PLANNING IN A CASE OF MAXILLARY DEFECT DUE TO TRAUMA

3D CT SCAN

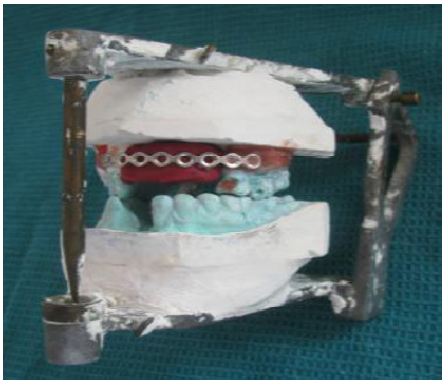


IMPRESSION MODELS

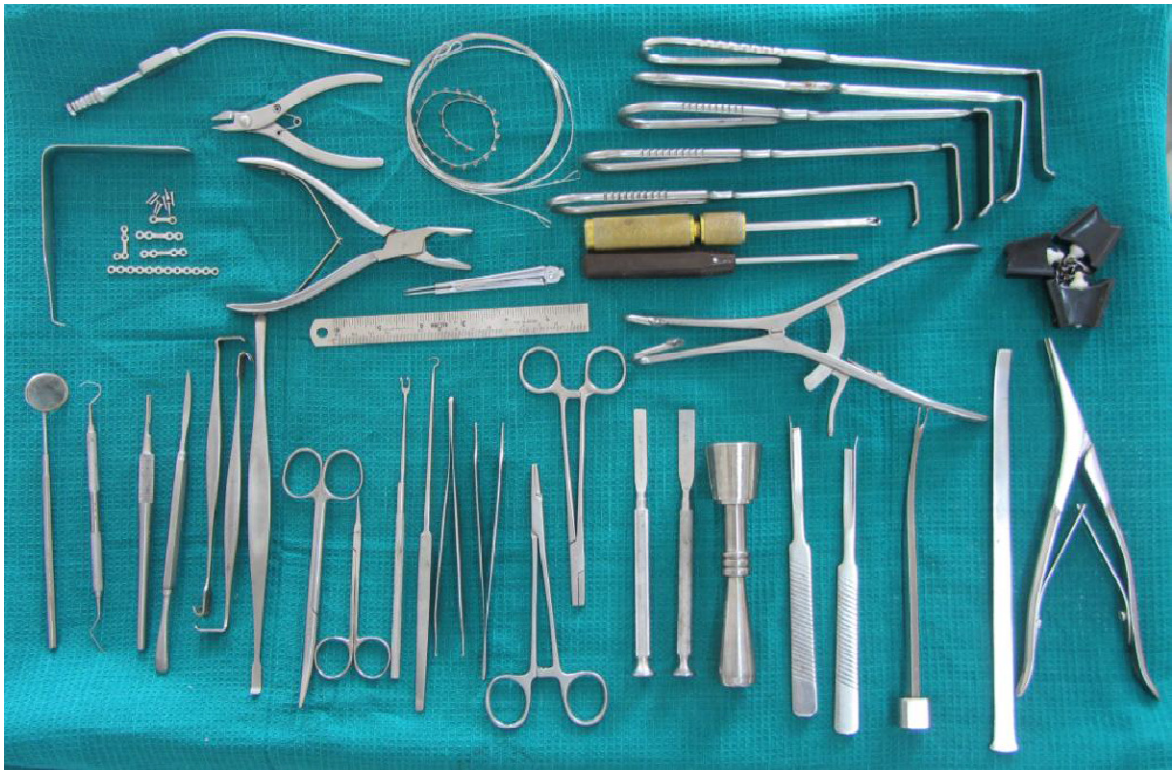
POSTERIOR MAXILLARY OSTEOTOMY



DEFECT TO BE RECONSTRUCTED IS DEPICTED WITH IMPRESSION COMPOUND



ARMAMENTARIUM



MICROMOTOR AND HANDPIECE

HAND HELD OFFICE DOPPLER

SURGICAL LOUPE & MICROSURGICAL INSTRUMENTS

OPERATING MICROSCOPE

Preoperative assessment of speech, facial nerve functions as well as infra orbital nerve sensation was carried out. All six patients had abnormal hyper nasal speech due to either mass effect of nasal cavity or presence of oro-nasal fistula due to secondary defects except one patient who presented with left maxillary odontogenic cyst without any oro-nasal fistula. None of them showed nerve weakness preoperatively.

All patients were treated in a similar fashion for maxillary reconstruction using micro vascular osseocutaneous free fibula flap.

Surgeries were carried out utilizing a two team approach. Excision of the maxillary tumour and preparation of the recipient site for reconstruction was done by one team while the other team completed the free fibula flap harvest. In all our cases, we utilised the services of our colleagues from Department of Oral and Maxillofacial Surgery, Government Dental College, Chennai, for resection and recipient site preparation, while we did the harvest and reconstruction part. Routine informed consent was obtained from all the patients.

In all cases surgery was performed under general anaesthesia. Nasal intubation was done in four of the cases were as sub mental intubation was performed in the remaining cases due to difficult nasal intubation.

In patients with primary maxillary tumour, excision of the lesion with adequate surgical clearance was done first. This was followed by dissection of recipient vessels and preparation of the recipient site, as was done in cases with secondary maxillary defects.

Simultaneously free fibula flap was harvested from the chosen leg, then careful Osteotomy cuts were made as preoperatively determined to simulate maxillary contour. The contoured fibula osseocutaneous flap was then first fixed to the recipient site at the predetermined site of fixation using stainless steel miniplates and screws.

Microvascular anastomosis was done in all cases using microsurgical instruments under the operating microscopic vision using 10 x magnifications.

Assessment of flap viability in the immediate post operative period is done by looking into the following parameters

1. Colour of the flap.
2. Capillary bleeding.
3. Temperature of the flap.
4. Doppler assessment of distal blood flow.

Charts to determine the functional and aesthetic outcome of the procedure were given to the patients in the follow up visits for recording the satisfaction level of patients.

Surgical technique

Harvest of fibula flap

After positioning the patient in supine position and parts painted and draped, the pneumatic tourniquet was inflated to 300mm hg pressure and the tourniquet time was noted. The knee was flexed to135 degrees and the hip was flexed to 60 degrees and internally rotated to facilitate the site of dissection.

Markings were made by drawing a line from the head of the fibula to the lateral malleolus to represent the subcutaneous border of fibula. The midpoint of this line was marked and it represents the site of entry of the nutrient artery to fibula. The design of the skin paddle was dictated by the individual defects that were to be reconstructed as well as the position of the perforators that were located preoperatively. The skin paddle for central defects had components for both nasal and palatal lining whereas those for the lateral defects without oro-nasal communication had only palatal component.

Skin incision was made along the markings of the flap and extended both proximally and distally as per the length of fibula that was required. Dissection first continued in the anterior aspect. The skin, subcutaneous tissue and the deep fascia incised along the anterior half of the flap markings, the anterior crural septum was incised, peroneous longus and peroneous brevis muscles identified retracted anteriorly and their attachment onto the fibula

separated carefully preserving a cuff of muscle around it to maintain the periosteal blood supply. Dissection proceeded in the same way close to fibula separating the extensor hallucis, extensor digitorum and peroneous tertius till the interosseous membrane was reached. The anterior tibial vessels and deep peroneal nerve were identified and retracted anteriorly and the interosseous membrane incised along its length from proximal to distal.

Dissection was then continued along the posterior aspect, the posterior flap marking incision deepened and the paddle was raised from posterior to anterior direction deep to deep fascia. The posterior crural septum was identified and presence of the perforators within it confirmed. Preserving the septum attached to the skin paddle dissection was then carried done to fibula along the septum separating soleus and flexor hallucis longus fibres.

At this stage periosteum was incised on the anterior aspect over the planned bone cut areas and a subperiosteal tunnel is created using a Howarth's elevator protecting the underlying pedicle. Using a oscillating saw proximal and distal osteotomies were made. The fibula was then held by means of bone holding forceps at both the proximal and distal ends and rotated. The rest of muscle attachments of flexor hallucis longus and tibialis posterior are then separated and the entire course of the peroneal vessels was made visible and further dissected up to its origin. Minor muscular branches that were encountered during this dissection were clip ligated and cut. The distal end of

the vessels was then ligated and cut so that now the entire fibula together with the skin paddle hangs free on its pedicle. Flap is the allowed to get perfusion, while recipient artery and vein were dissected.

Osteotomies for contouring the fibula to fit the maxillary defect was then performed with the help of oscillating saw, while keeping the flap perfused, in order to reduce the ischemia time. Once perfusion of the flap after contouring had been done was confirmed, the pedicle was transacted and the flap was transferred to the recipient site for fixation and microvascular anastomosis.

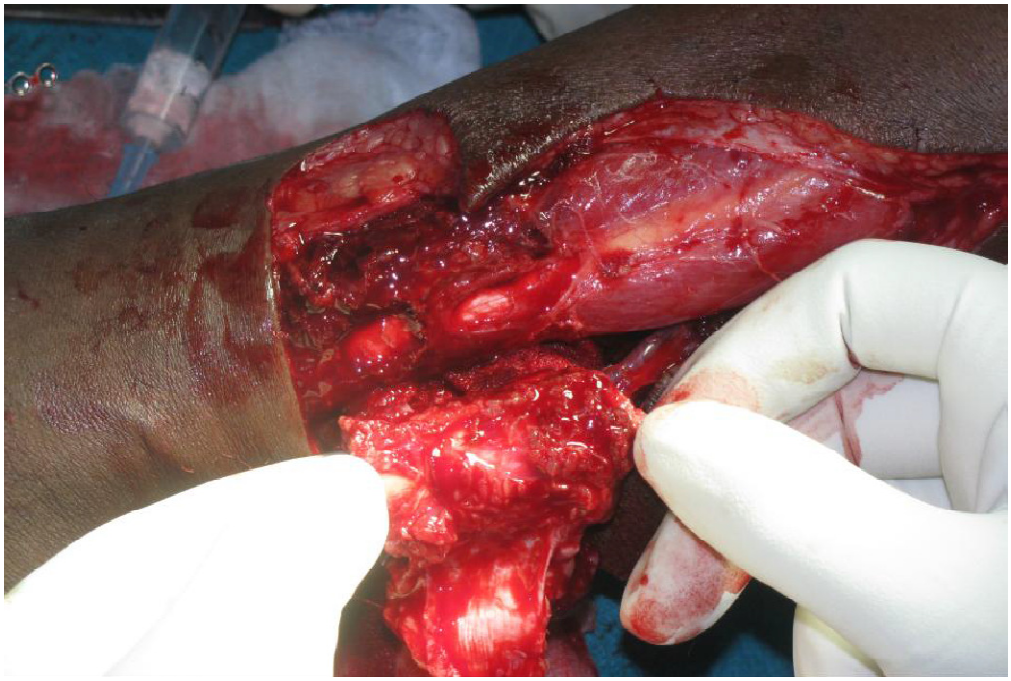
SURGICAL TECHNIQUE FOR HARVESTING FREE FIBULA FLAP

MARKING OF INCISION AND SKIN PADDLE FOR PALATAL DEFECT

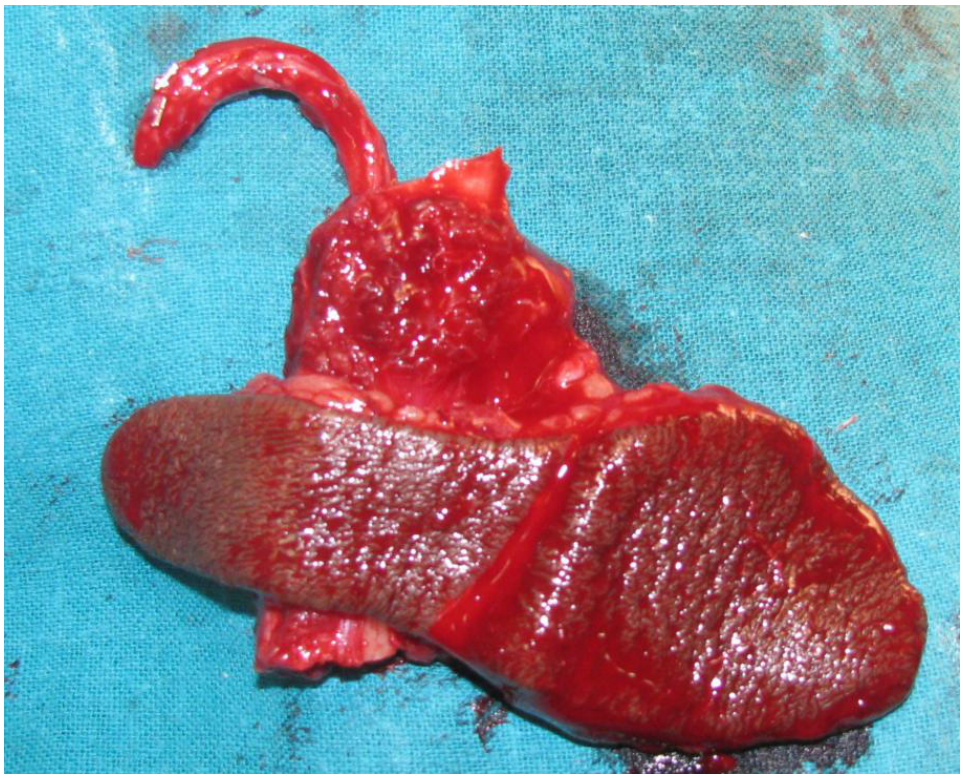
INCISION PLACED

DISSECTION

OSTEOTOMY CUT COMPLETED AND FLAP HARVESTED



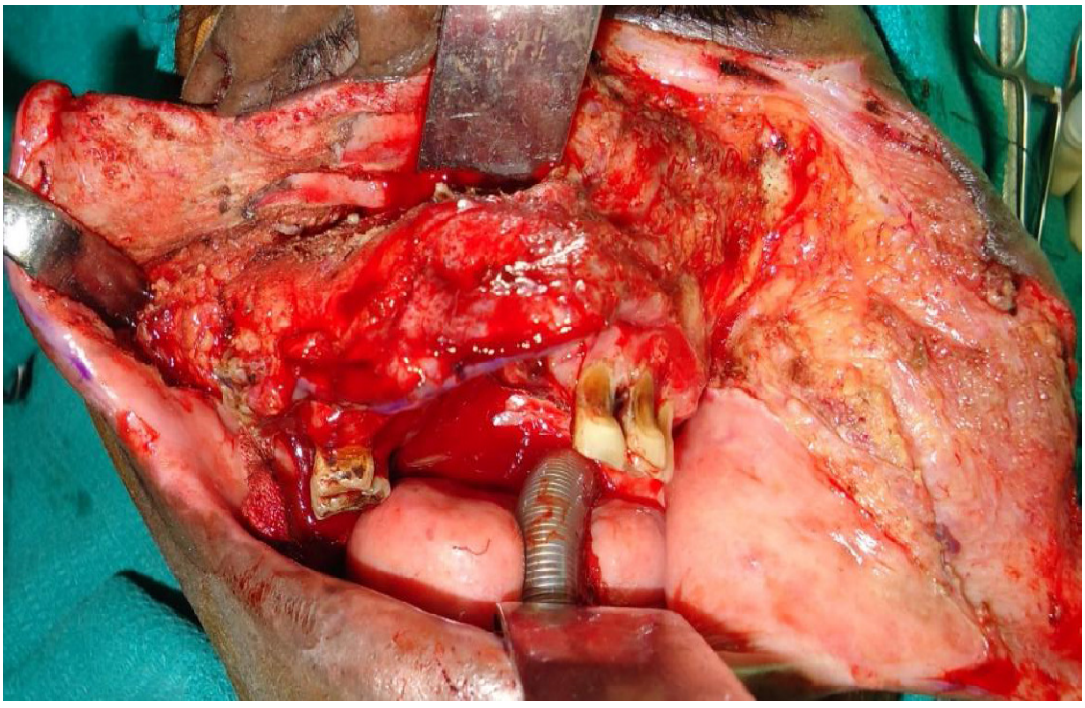
HARVESTED OSTEOCUTANEOUS FREE FIBULA FLAP



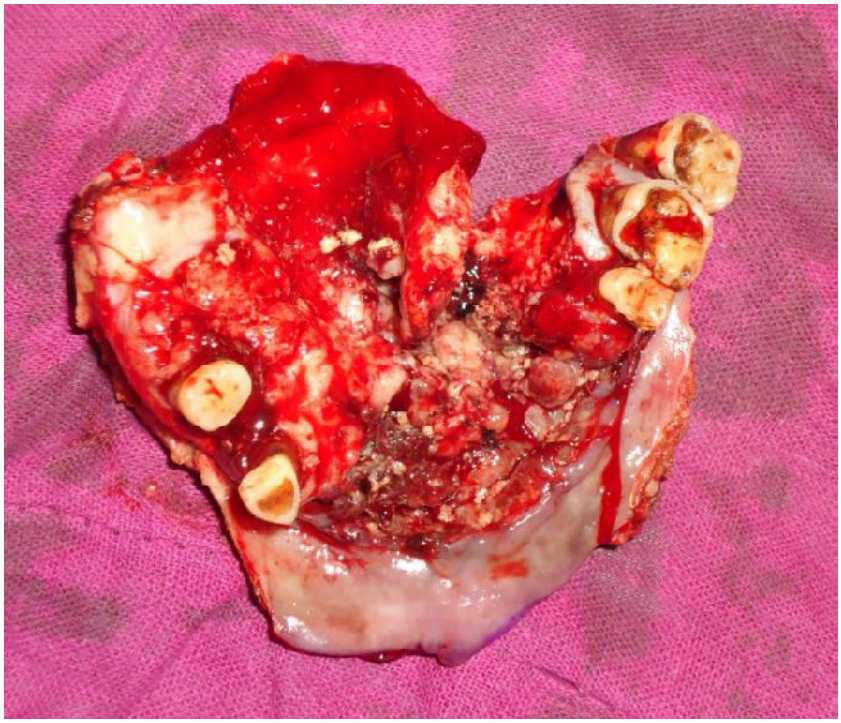
SURGICAL TECHNIQUE FOR FIXATION OF FIBULA FLAP TO MAXILLARY DEFECTS

WEBER FERGUSSION INCISION MARKED

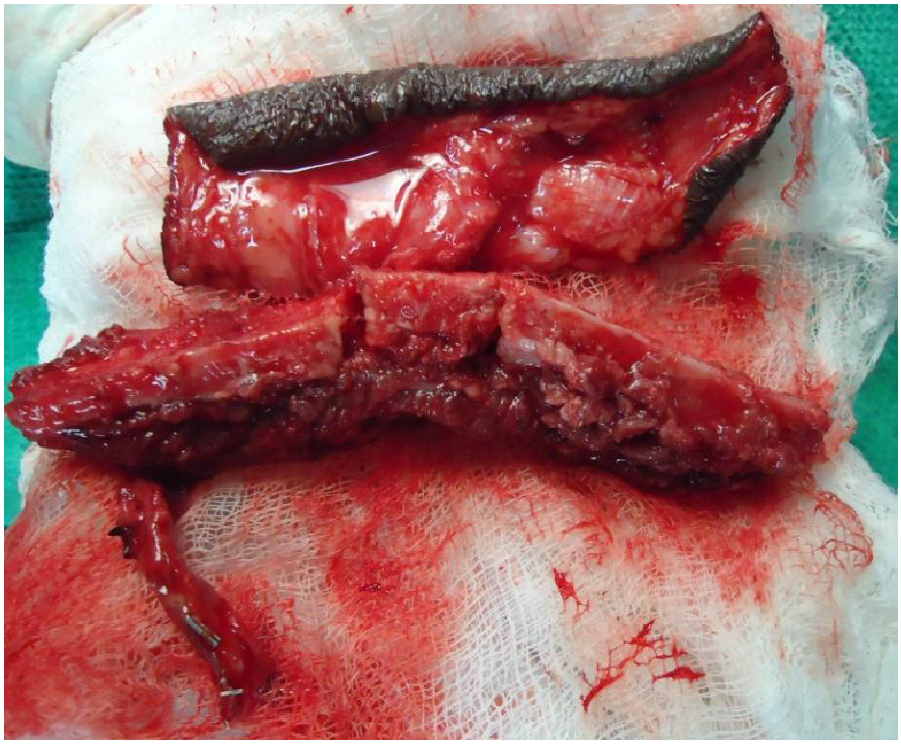
FLAP REFLECTED



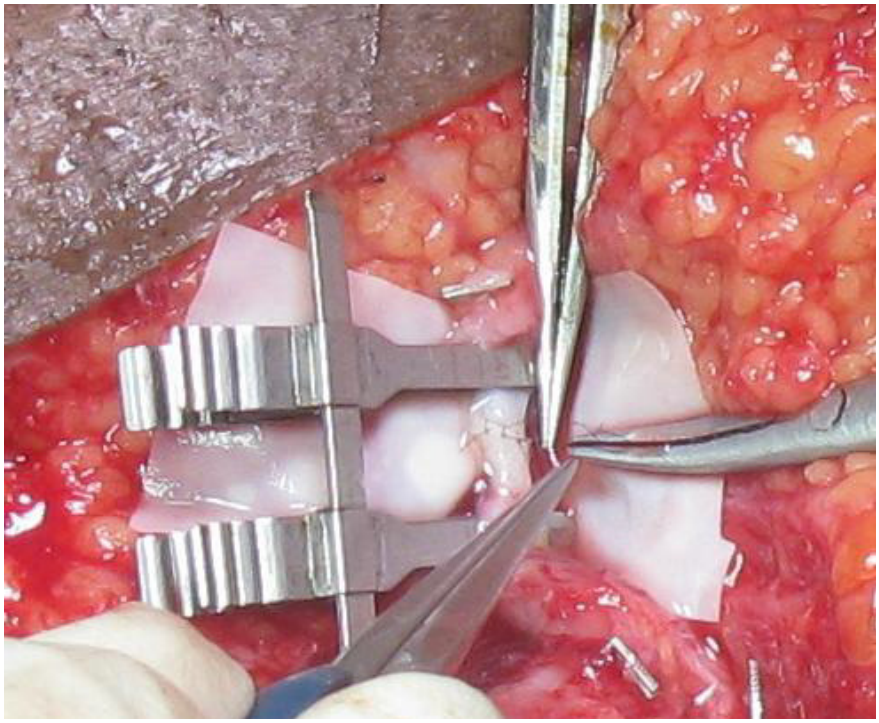
RESECTION OF MAXILLARY LESION



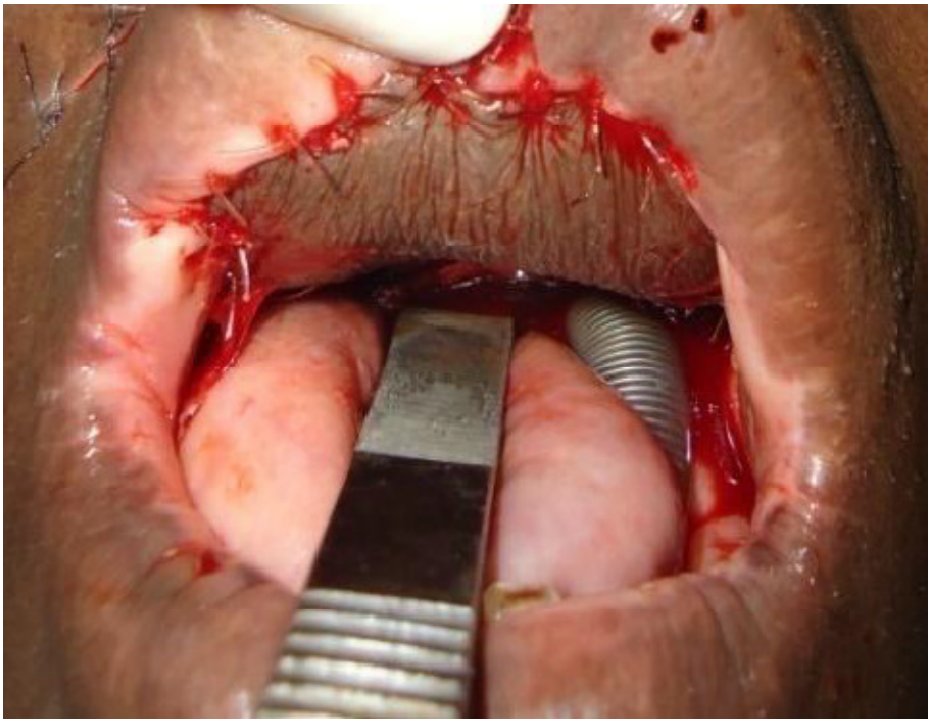
FIBULA SHAPED LIKE MAXILLA BY MAKING OSTEOTOMY CUTS



MICROVASCULAR ANASTOMOSIS



FIBULA FLAP FIXED TO MAXILLARY DEFECT AND SUTURED



The transported free fibula flap after re-orienting it over the defect is then fixed to the surrounding zygoma/ piriform ring using miniplates and screws.

Micro vascular anastomosis was done first between peroneal artery and facial artery and then between peroneal vein and facial vein, using 9-0 nylon suture with M.E.T needles, operating microscope with 10x magnification, micro instruments and approximating clamps.

At the completion of microvascular anastomosis the flap checked and confirmed for capillary bleed. Final flap inset was then completed after keeping suction drain. Reconstructed site was then thoroughly washed with saline and betadine.

The donor site defect was grafted using split thickness skin graft harvested from opposite side thigh and fixed using 3-0 absorbable suture. A below knee POP cast was applied to the donor limb with ankle at neutral position.

Maxillary Resection Technique

Maxillary resection was approached by extra oral incision in all cases. The head was supported on a head ring and neck is extended with the help of a shoulder bag. The head was slightly tilted to the opposite side for ease of access. Surgical site was then painted with betadine and draped in a standard fashion.

Weber Fergusson's incision was marked on the side of the lesion and good access was achieved with Dieffenbach's modification[41]. Incision was made according to the extent of defect and its access.

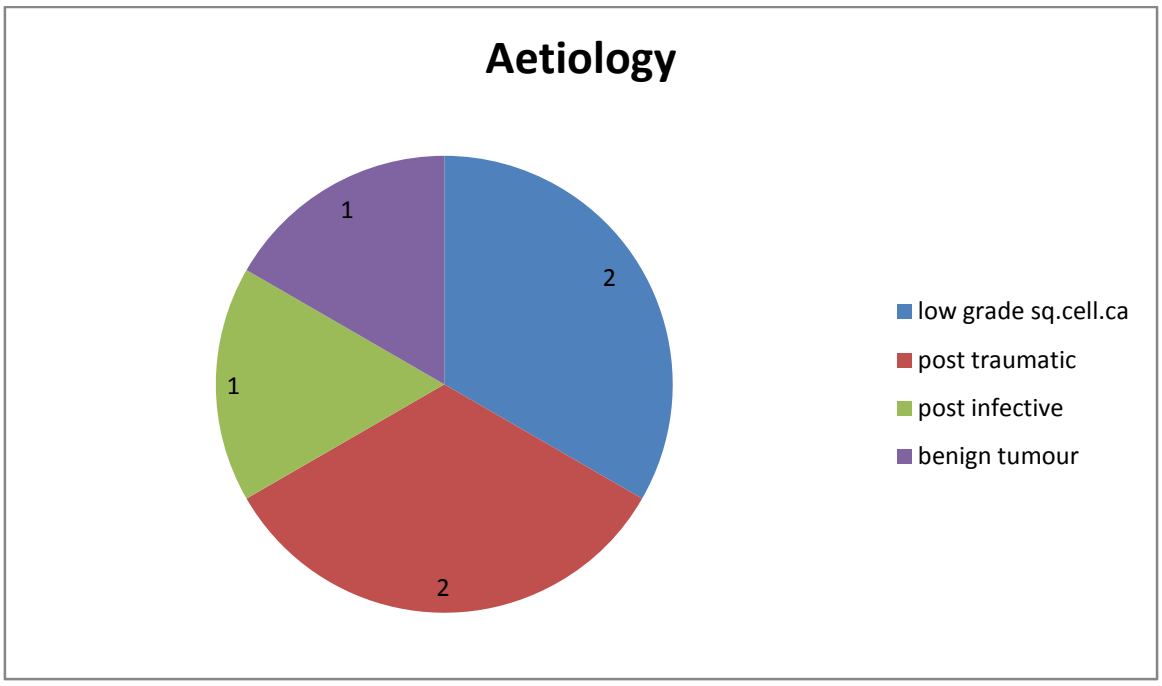
Incision was made using a no 15 blade. Dissection was carried out layer by layer from skin, subcutaneous tissue, SMAS layer and to the Periosteum. A small submandibular incision marked on the side of lesion or defect and incised. Dissection was done and facial artery and vein identified and preserved.

The maxillary lesion was then excised with safe margins all around. In case of secondary reconstruction the reepithelialised skin and mucosal margins were trimmed and the defect was recreated.

Observation and Results

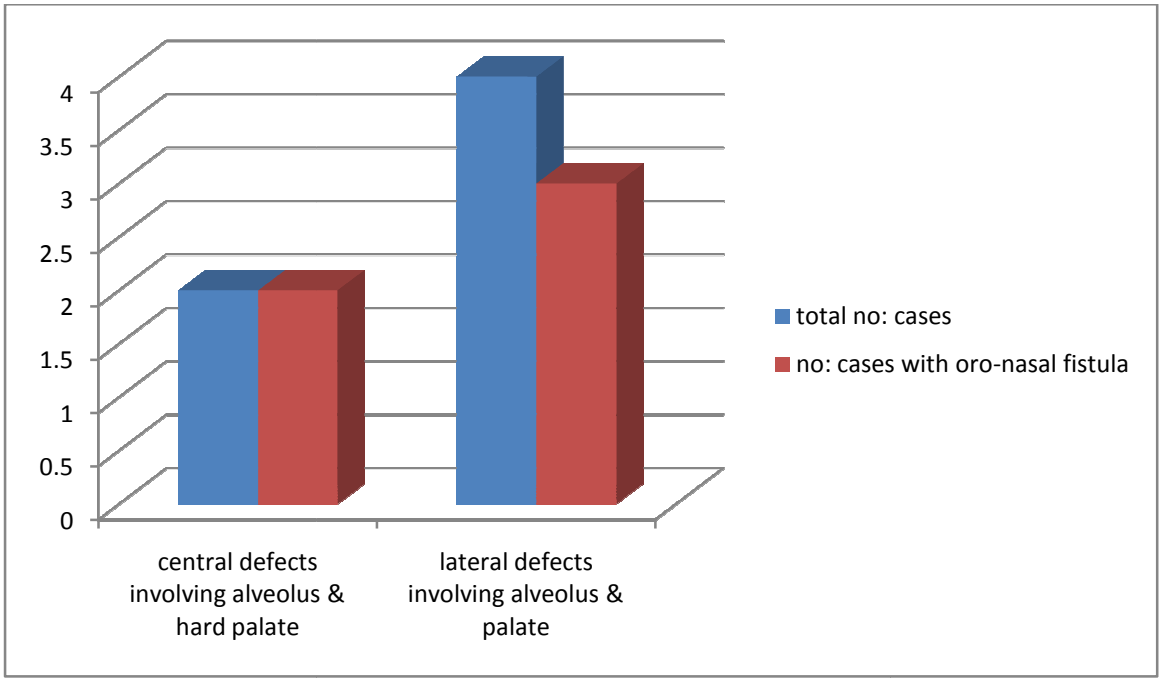
Totally six patients underwent maxillary reconstruction using free fibula in our study. All of them were male patients. Age ranged between 23 and 57 years.

The aetiology and defect descriptions were as shown in the diagrams below



Among six patients three had primary maxillary lesions requiring excision followed by reconstruction and in the remaining three cases with secondary maxillary defects (post traumatic – 2; post infective – 1), patient needed defect recreation and reconstruction only.

Distribution of defects



Four of the cases had lateral defects; all of them were on the left side of maxilla involving the alveolar process and lateral aspect of hard palate, oro-nasal fistula with nasal regurgitation was present in three of the four cases.

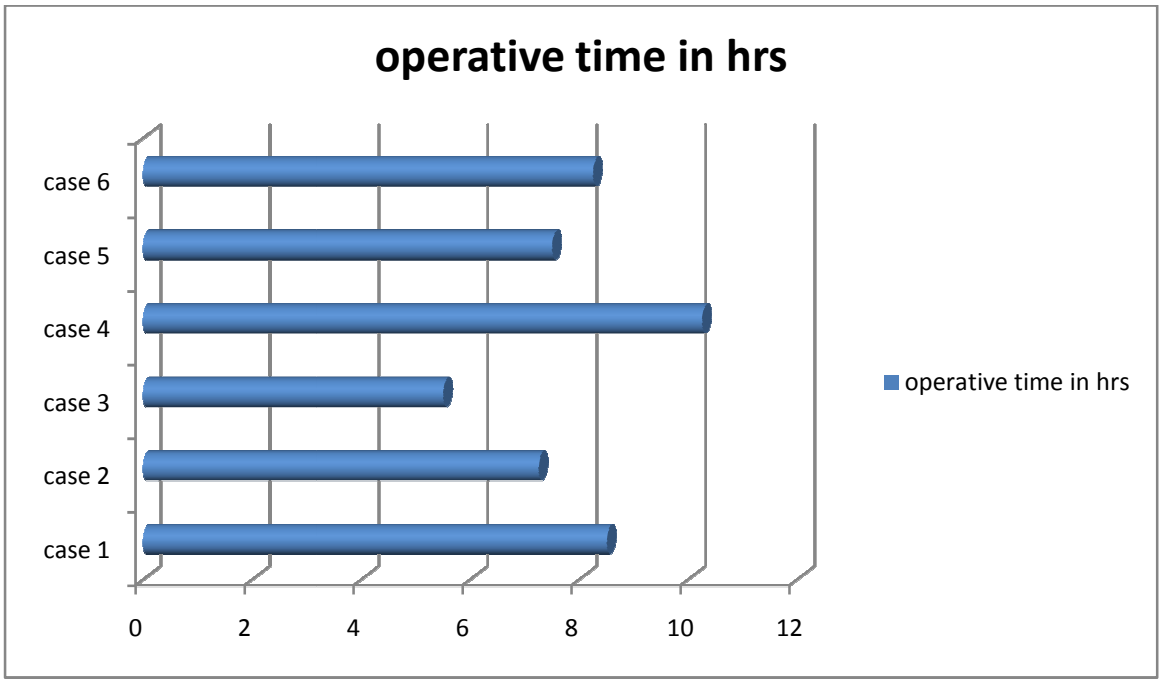
Two of the six cases had central defects; both of them were due to squamous cell carcinoma of the central alveolar process, extending onto anterior 1/3 palate, both presented with oro-nasal fistula and regurgitation.

The operative time for the whole procedure lasted between five and eleven hours.

The shortest operating time was achieved in case 3 with secondary maxillary defect due to mucormycosis involving the left alveolar process of

maxilla. Patient had undergone left partial maxillectomy five months ago, presented to us with lateral defect and nasal regurgitation.

The longest operating time was noticed in case 4 with malignant keratinizing squamous cell carcinoma of the alveolar process along the midline with extension onto the hard palate, requiring composite resection with reconstruction.



The following table shows the parameters that were assessed during the preoperative evaluation of the patients. All of them showed mild facial asymmetry, except for case 3 with left partial maxillectomy defect secondary to mucormycosis infection, which had moderate facial asymmetry on the left side with hollowness of cheek.

Occlusal derangement was noticed in four of the cases with lateral defects. In case 2 with odontogenic cyst, due to expansile lesion of the alveolus anterior open bite with posterior cross bite on the right side was noted. In case 3, posterior open bite on the right side was seen due to collapse of the left maxillary arch. Case 5 & case 6 had maxillary defects secondary to trauma with maxillary retrusion and anterior cross bite and class III Occlusal deformity.

	Hyper nasal speech	**Nasal regurgitation of feeds**	**Facial asymmetry noticed**	**Occlusal derangement**
Case 1	yes	Yes	mild	Nil
Case 2	No	No	mild	Yes
Case 3	yes	Yes	moderate	yes
Case 4	yes	Yes	mild	Nil
Case 5	yes	Yes	mild	yes
Case 6	yes	yes	mild	yes

Maximum follow up period in our study was 28 months and the minimum follow up period was 6 months.

Complications at the recipient site as well as donor site morbidity were expressed as shown in the tables below

Early	**% (No: of Cases)**
haematoma	16.3(case no: 3)
Infection / wound dehiscence	16.3(case no: 3)
Flap necrosis	Nil
Sensory / motor disturbance of face	Nil
Late	
Hardware exposure	Nil
Recurrence at the operated site	Nil
Malocclusion	Nil

Donor site morbidity was assessed one month after surgery, and were expressed as shown in the table below

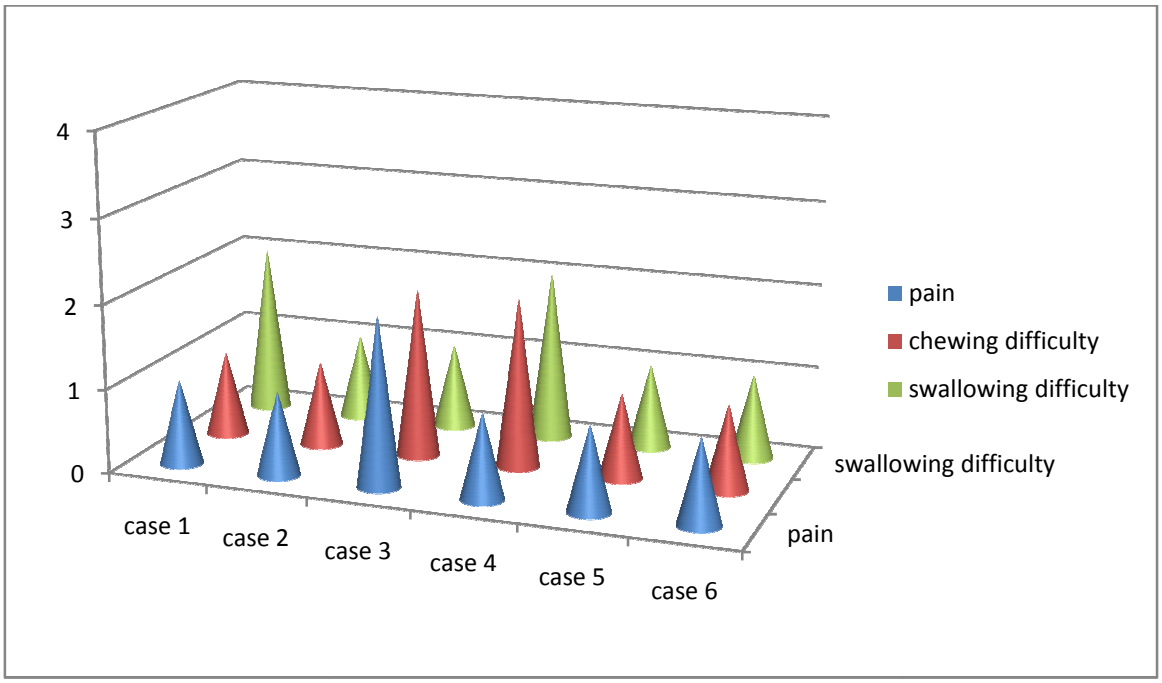
Factors	% (no: of cases)
Pain	Nil
Gait disturbances	Nil
Sensory loss	Nil
Motor weakness	Mild eversion weakness noticed, improved after few months.
Ankle joint instability	Nil

Patient's satisfaction in terms of functional and aesthetic outcome after surgery was expressed by means of four point grading scale and visual analogue scale.

Functional outcome at recipient site

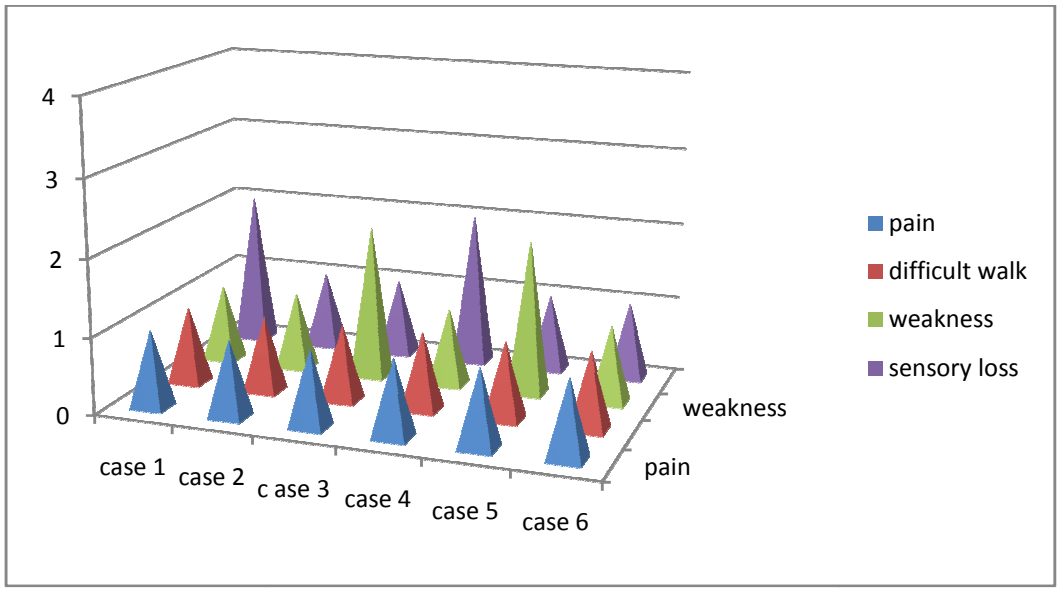
The chart shown below displays the functional outcome in terms of patient's satisfaction at the recipient site which takes into account three variables graded on a four point grading score as indicated. 1(never experienced); 2(rarely seen); 3(often seen) & 4(always seen). All of them showed good functional outcome with regards to recipient site.

Functional Outcome at Recipient Site



The functional disturbances experienced by the patients at the donor site were also expressed in terms of a four point grading system incorporating the variables as shown in the chart below

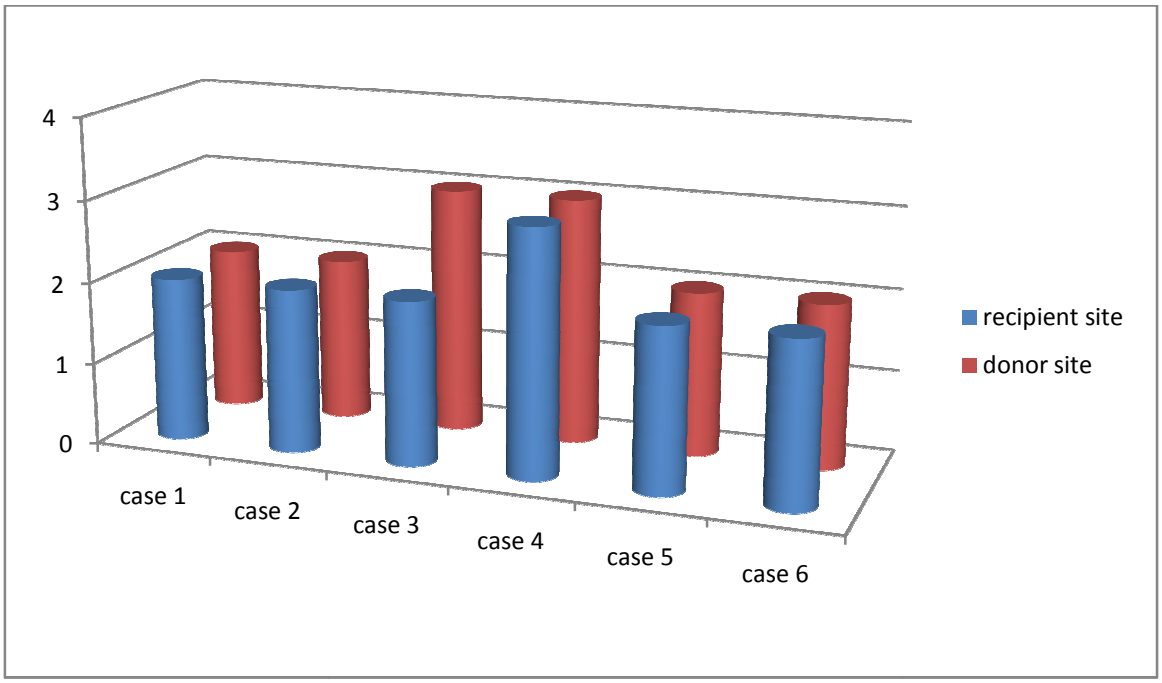
Functional Outcome at Donor Site



All the six patients did not had any pain or difficult in walking after the procedure. Two patients had mild eversion weakness during the early follow up period, which gradually improved during the subsequent visits. Mild paraesthesia was experienced in two patients along the dorsum of foot during the early post operative period but then complete recovery was seen in both the cases.

The aesthetic outcome according to patient's satisfaction was assessed by means of visual analogue scale given to the patient during the follow up period. Outcomes were graded as very good, good, fair or poor by the patient both for the donor and recipient sites as shown below. All of them showed good to fair outcome as their satisfaction towards the results.

Aesthetic Outcome at Donor & Recipient Site



CASE REPORT

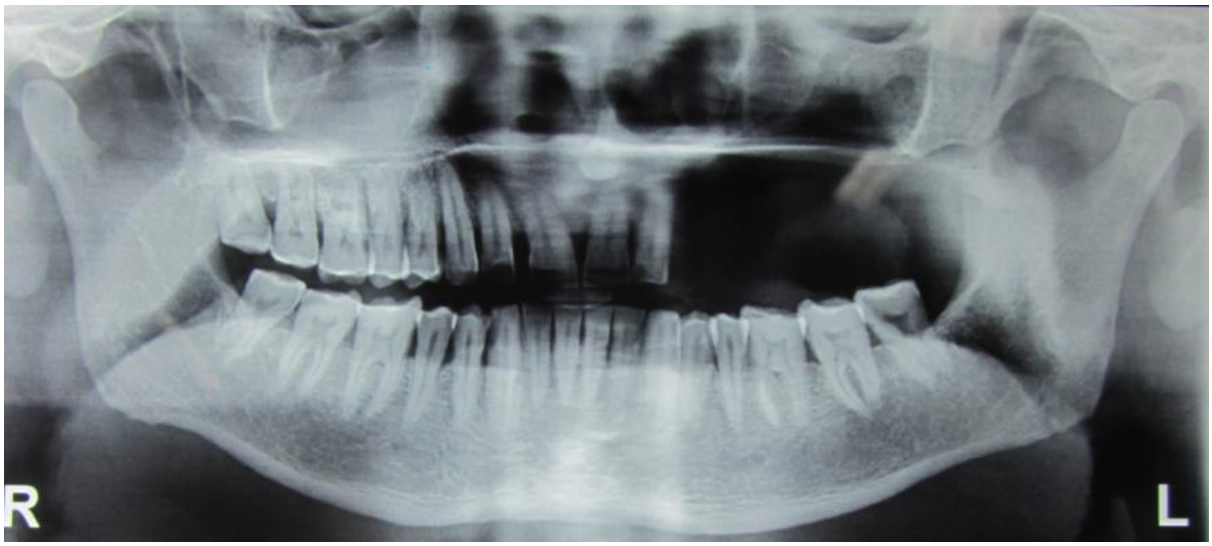
CASE: 3

PREOPERATIVE

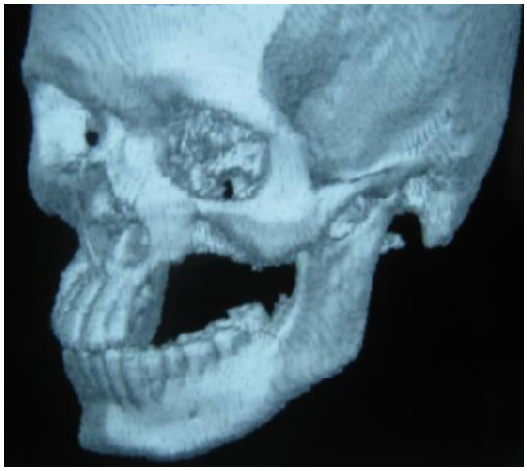
EXTRA ORAL

INTRA ORAL

ORTHOPANTOMOGRAPH



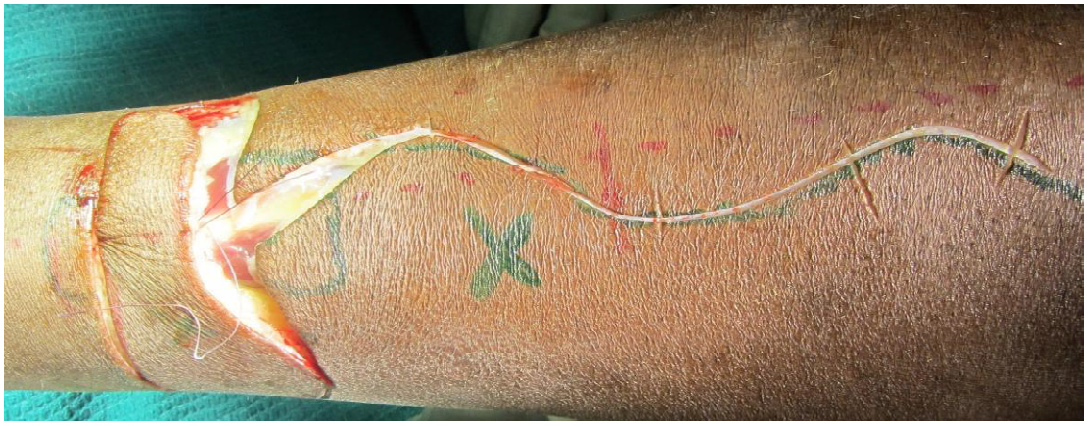
DEFECT IN 3D CT SCAN



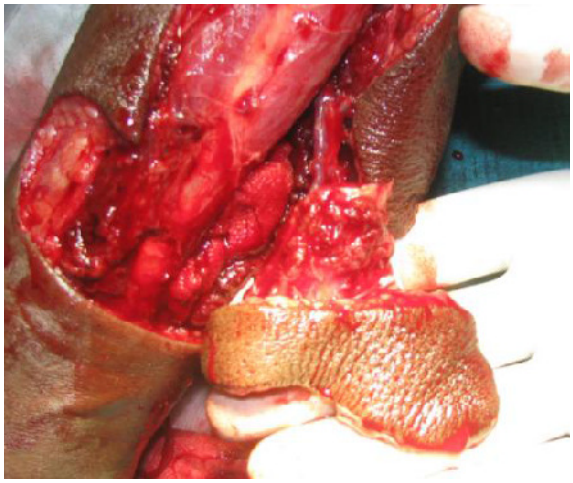
PLANNED RECONSTRUCTION

INTRAOPERATIVE

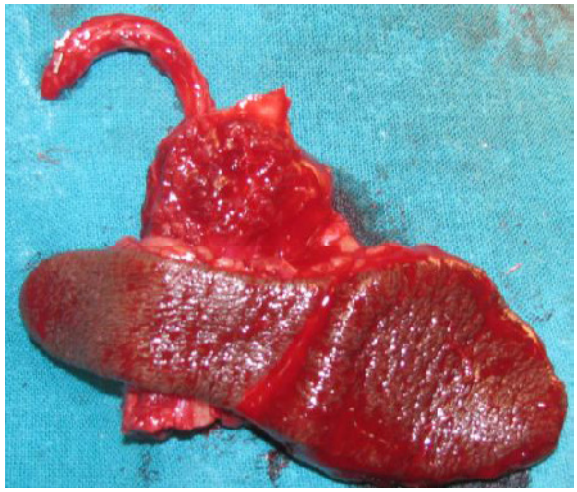
INCISION



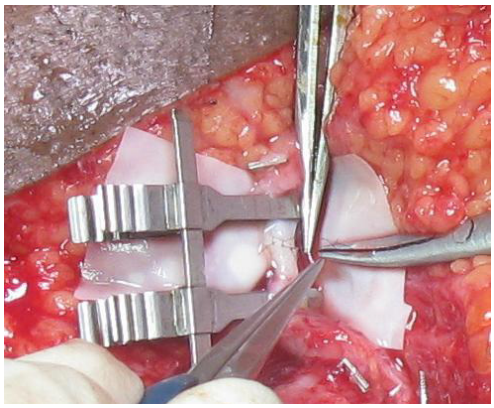
DISSECTION AND FLAP HARVEST



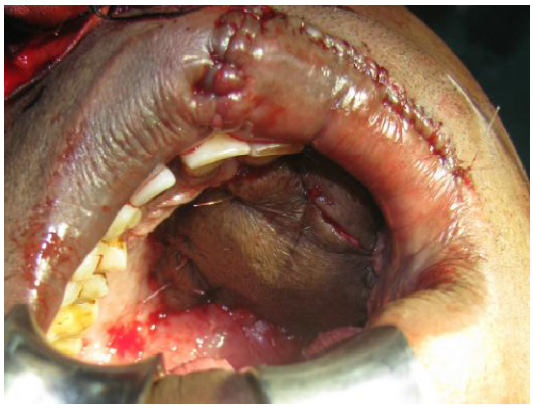
HARVESTED FREE FIBULA FLAP



MICROVASCULAR ANASTOMOSES



INTRAORAL FIXATION & CLOSURE

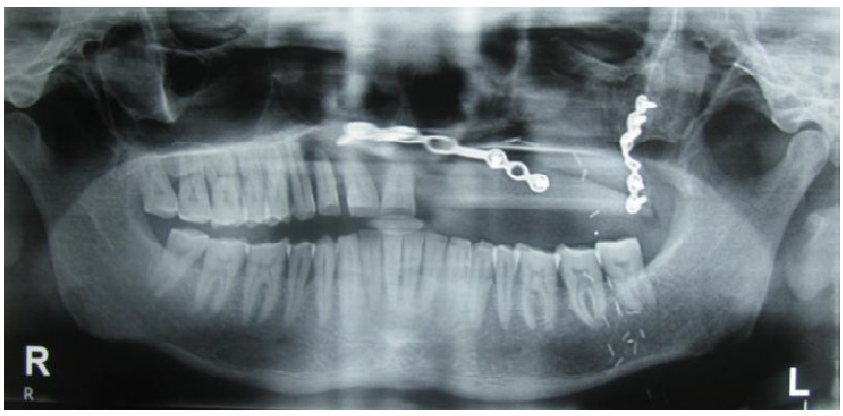


POST OPERATIVE

EXTRA ORAL

INTRA ORAL

ORTHOPANTOMOGRAPH



PARANASAL SINUS VIEW

DONOR SITE AFTER FOUR MONTHS

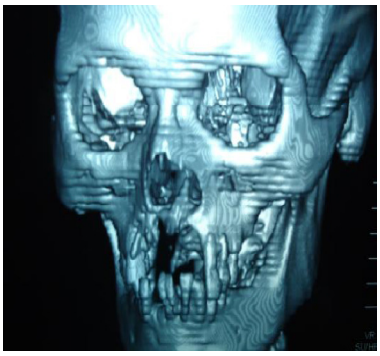
CASE: 4

PREOPERATIVE

EXTRA ORAL

INTRA ORAL

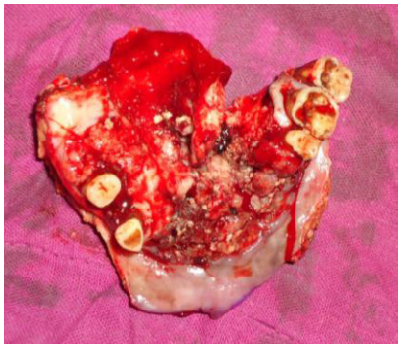
PREOPERATIVE CT SCAN



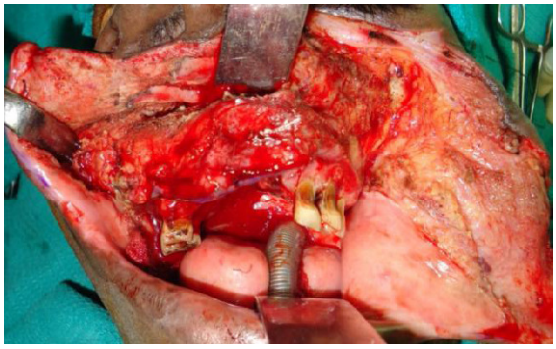
PREOPERATIVE IMPRESSION MODEL

INTRAOPERATIVE

RESECTION OF LESION

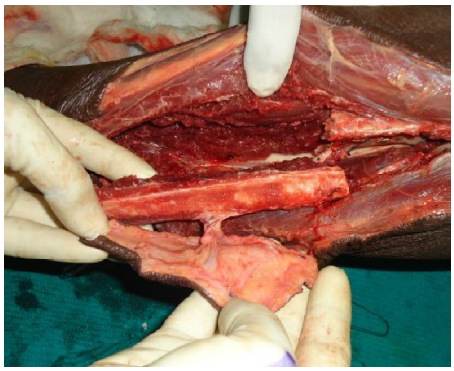


FLAP REFLECTED

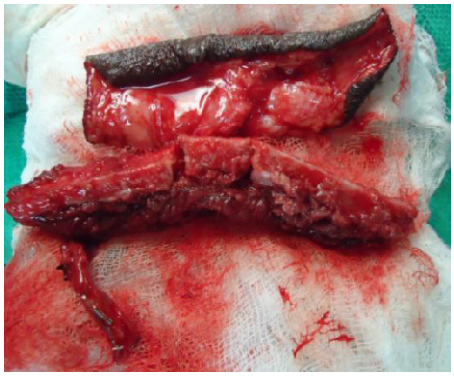


INCISION AND FLAP MARKED

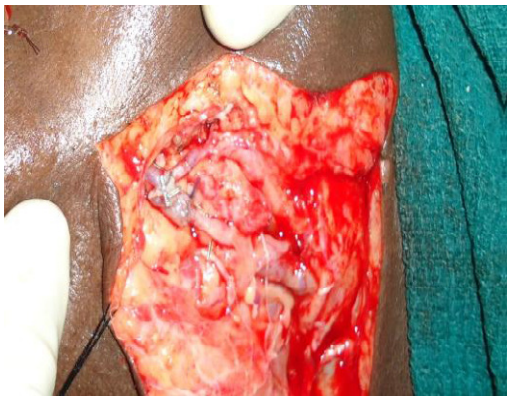
DISSECTION AND HARVEST



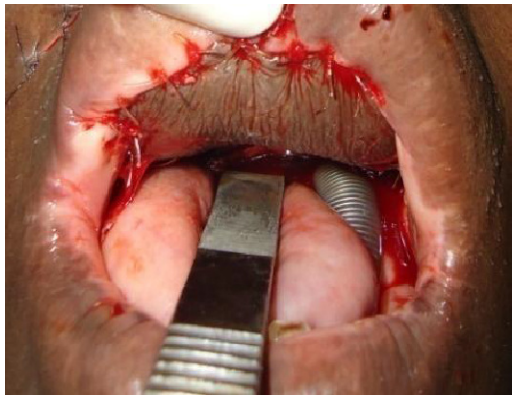
OSTEOTOMY CUT FOR SHAPING



MICROVASCULAR ANASTOMOSES



FLAP SUTURED



POSTOPERATIVE

EXTRA ORAL

INTRA ORAL

CASE: 6

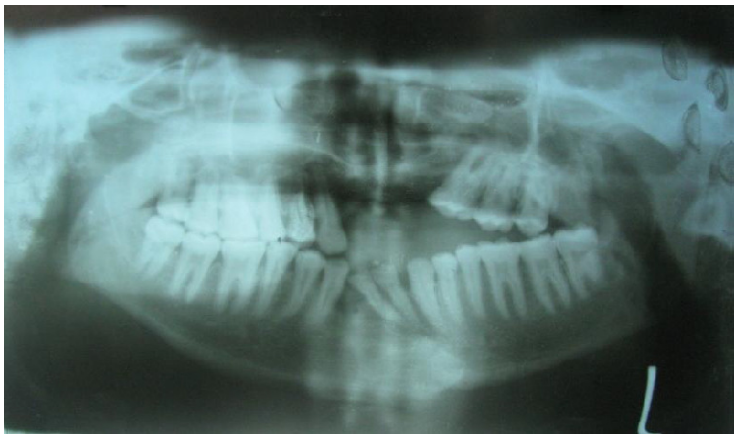
PRE OPERATIVE

EXTRA ORAL

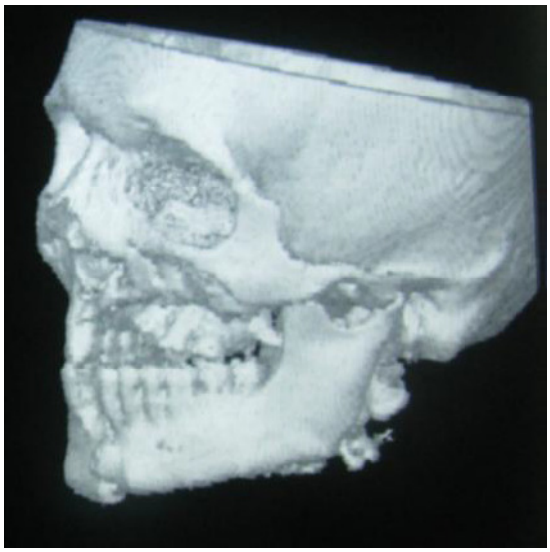
INTRA ORAL

PNS VIEW

ORTHOPANTOMOGRAPH



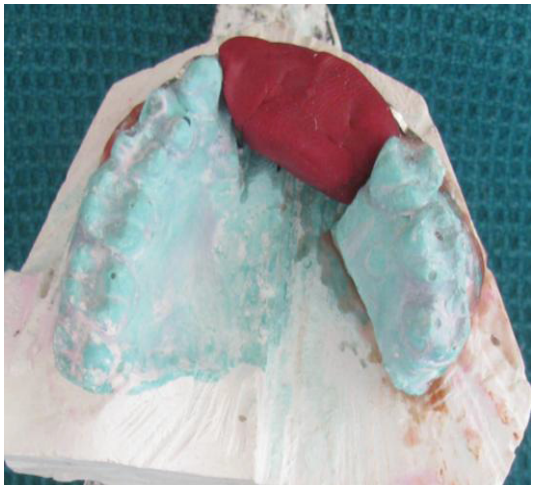
3D CT SCAN



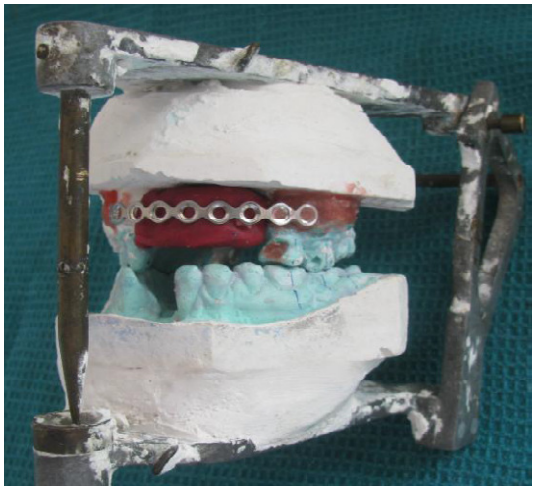
PREOPERATIVE IMPRESSION MODELS AND SURGICAL PLANNING

UPPER MODEL MOCK SURGERY

AMOUNT OF GRAFT NEEDED IS MADE BY IMPRESSION COMPOUND

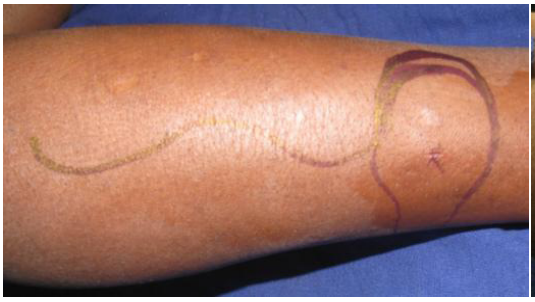


ADAPTED WITH MINIPLATE IN THE MODEL



INTRAOPERATIVE

INCISION MARKED



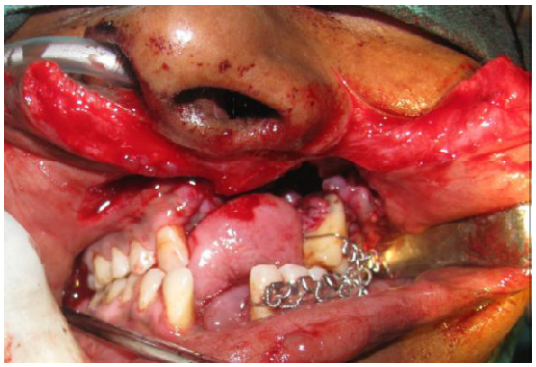
DISSECTION

OSTEOTOMY OF FIBULA COMPLETED

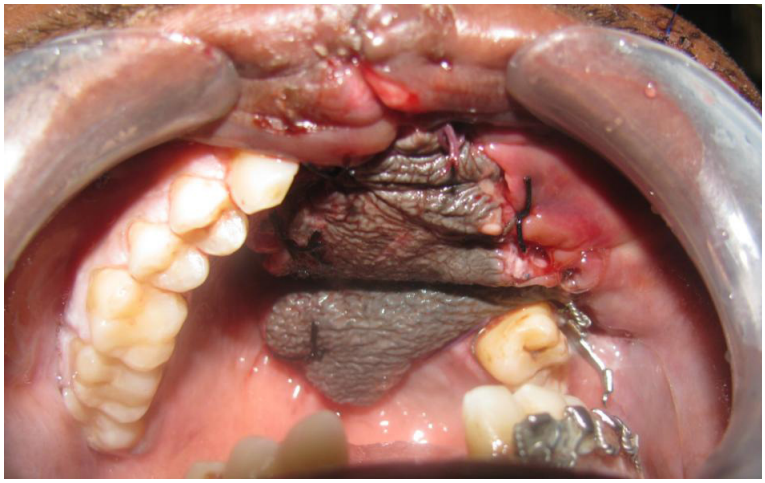
HARVESTED FLAP

LATERAL RHINOTOMY INCISION

POSTERIOR MAXILLARY OSTEOTOMY AND FIXATION



FIBULA FLAP FIXED AND SUTURED



Discussion

Maxillary reconstruction has always been a challenge for the reconstructive plastic surgeons, involved in oro-maxillo-facial reconstruction.

Reconstructive goal in maxillary reconstruction is said to be achieved only when the form, function and contour of the midface architecture is restored by means of a aesthetically acceptable result.

Traditionally, prosthodontic management of palatal defects has been in use for many years. It has stood the test of time through evolution of newer designs[42, 43], yet it has only partially fulfilled the goals and needs a continuous refinement of it for every individual.

Free fibula flap was described first by Taylor and his colleagues in 1975, for reconstruction of lower extremity defects. Later Hidalgo[44] in 1989 described the use of free fibula flap for mandibular reconstruction and since then the free fibula flap has become the mainstay of reconstructive oro-maxillo-facial surgery.

It provides sufficient bone length needed for the reconstruction of alveolar arch defects and the required bone stock for further Osseo-integrated implant placement. There by restoring the form as well as the function that has been lost.

The reconstructive goals to be achieved in maxillary reconstruction as addressed by Neal.D.Futran[45] in 2005, includes the following

1. Restoration of mucosal continuity with consistent wound healing
2. Restoration of palatal competence
3. Restoration of facial contour
4. Recreating a functional dentition

Free fibula flap has many advantages[46] over the other reconstructive options. Like,

1. Lengthy vascular pedicle
2. Larger calibre peroneal vessels for anastomosis
3. Composite flap structure
4. Availability of a large cutaneous paddle
5. Minimal donor site morbidity
6. Ability to be contoured to suit the defect
7. Applicability of two team approach.

However free fibula flap is ideally suited for class I and class II maxillary defect reconstruction as compared to that of more extensive class III and class IV defects.

Preoperative Doppler examination of the lower limb should be performed in all cases in order to accurately detect the perforators that supply the skin paddle, which has to be preserved during surgery. 8 Hz hand held Doppler was used for our study for picking up the perforators as well as to map the recipient artery and vein.

In our study primary reconstruction was done for three cases and in the remaining three cases maxillary defects were secondarily reconstructed. There were no significant differences in terms of operative time for primary and secondary reconstruction in our study. 'Two team' approach was followed in all our cases and it had significantly reduced the overall operative time.

In harvesting free fibula flap the lateral approach technique was followed in all our cases as we found it technically easier and faster to harvest compared to the anterior approach technique.

We used operative microscope with 10X magnification for the microvascular suturing in all our cases and found it to be effective with 100% patency rates, however setting up the microscope and focus of the field prior to suturing takes a bit longer time when compare to ocular loupes. The ocular loupes with 4X to 6X magnification can also be effectively used for microvascular anastomosis provide the vessels are of larger calibre (1.5 – 2.5mm).

In order to prevent formation of thrombus at the anastomotic site, it was our practice to have continuous irrigation of heparinised saline solution at the vessel ends during intra-operative phase of anastomosis and to use anticoagulants in the form of low molecular weight dextran and aspirin during the first three postoperative days.

Flap survival was 100% in our study and we think that it's because of proper case selection, accurate preoperative planning, meticulous operative technique, excellent team approach, fine microvascular suturing technique and highly vigilant postoperative follow up care.

Complications in our study are very minimal, in the form of infection and wound dehiscence which were managed easily.

Our study had a maximum follow up period of thirty months and with that we found that the overall satisfaction of the patient in terms of functional and aesthetic outcome after reconstruction of maxillary defects using free fibula flap to be good.

Thus the free fibula flap provides a well vascularised flap for reconstruction of maxillectomy defects. The overall success of this flap has made this flap a valuable option for reconstruction of maxilla and midface. Based on our little experience with the use of free fibula flap it appears to be a safe, reliable, and convenient method of maxillary reconstruction.

Conclusion

Midface reconstruction is a more complex operation than other part of facial region for a reconstructive surgeon, because the defect is considerably farther from the recipient vessels in the neck. Reconstruction can be achieved with predictable results using micro vascularised free fibula flap.

Outcome of our study and review of literature have shown that free fibula provides excellent quality of hard and soft tissue to reconstruct simple and composite maxillary reconstruction.

Though the amount of hard tissue provided is satisfactory for the defect, the soft tissue bulk is abundant. It would require careful trimming to accommodate in the oral cavity, hence proving to be a laborious task.

Though the number of cases in our study is less the results were satisfactory.

In conclusion, low donor site morbidity, acceptable aesthetic and functional outcome recommends micro vascularised free fibula flap to be considered as one of the ideal option for maxillary reconstruction. However long term results of success of the flaps and possibility of placement of implants in it requires a further study in a larger sample.

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PROFORMA

THREE DIMENSIONAL RECONSTRUCTION OF MAXILLA USING FREE FIBULA FLAP

Patient's name : .....

Age/sex : .....

IP NO: : .....

Contact address : .....

.....

.....

Contact number : .....

Preoperative details:

1. Defect nature (primary/secondary); 2. Aetiology (.....) ; 3. Site (central/lateral) ; 4. Hyper nasality (yes/no) ; 5. Facial asymmetry (present/absent) ; 6. Occlusion (normal/deranged) ; 7. Mastigatory difficulty (yes/no) ; 8. Nasal regurgitation (yes/no).

Co-morbidity : .....

Risk factors : .....

Donor site assessment : .....

Intraoperative details:

Procedure done - .....

.....

Harvest approach (lateral/anterior) ; skin paddle size : ..... ; perforator nos : ..... ; length of fibula harvested : ..... ; size of peroneal vessels (artery : ..... / vein : .....) length of pedicle : ..... ; duration of harvest : ..... ; tourniquet time : ..... ; ischemia time : ..... ; suture material : ..... ; microvascular technique (end:end/end:side/intergraft) ; vein anastomosis : single/double.

Duration of procedure - .....

Anticoagulants used : .....

Investigators name/signature : .....

MASTER CHART

	Age /sex	IP NO	aetiology	Risk factors	Defect size/site	speech	Nasal regurgitation	occlusion	Feeding difficulty	Preoperative Doppler study	Approach of harvest of fibula	Mean operating time	Ischemia time	Tech of anastomosis	Flap outcome	complications	Functional outcome	Aesthetic outcome
Case 1	45 M	8377	Sq.cell.ca Low grade/primary	-	6x4cm/anterior	Hyper nasal	Yes	No	+	Yes	Lateral	8.5	1’20”	End to end/ single vein	Settled	–	Good	Good
Case 2	36 M	117312	Odontogenic cyst/primary	-	3x2cm/lateral alveolar	Normal	No	Yes	–	Yes	Lateral	7.25	0’45”	End to end/single	Settled	–	Very good	Good
Case 3	23 M	23055	Mucormycosis/secondary	-	5x3cm/lateral alveolar	Hyper nasal	Yes	Yes	+	Yes	Lateral	5.5	1’15”	Interposition vein graft / single vein	Settled	–	Good	Fair
Case 4	57 M	27054	Keratinizing sq.cell.ca/ primary	hypertension	5x4cm/central alveolar	Hyper nasal	Yes	No	+	Yes	Lateral	10.25	2’13”	End to end/single vein	Wound dehiscence / flap resutured no loss	Haematoma	Good	fair
Case 5	37 M	63837	Post trauma/secondary	-	4x2cm/lateral alveolar	Hyper nasal	Yes	Yes	+	Yes	Lateral	7.5	1’05”	end to end / single	Settled	–	Very good	Good
Case 6	27 M	86148	Post trauma/secondary	-	5x5cm/lateral alveolar	Hyper nasal	Yes	Yes	+	Yes	Lateral	8.25	2’25”	End to end / single	Settled	–	Very good	Good

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI -3

Telephone No : 044 25305301
Fax : 044 25363970

CERTIFICATE OF APPROVAL

To

Dr.C.Prabakar,
III Year, Post Graduate,
Department of Plastic, Reconstructive & Faciomaxillary Surgery,
Madras Medical College & RGGGH, Chennai -3

Dear Dr.C.Prabakar,

The Institutional Ethics committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled "Three Dimensional Reconstruction of Maxilla Using free Fibula Flap" No.27022013.

The following members of Ethics Committee were present in the meeting held on 05.02.2013 conducted at Madras Medical College, Chennai -3.

1.	Dr.SivaKumar, MS FICS FAIS	--- Chairperson
2.	Prof. R. Nandhini MD Director, Instt. of Pharmacology ,MMC, Ch-3	-- Member Secretary
3.	Prof. Shyamraj MD Director i/c , Instt. of Biochemistry , MMC, Ch-3	-- Member
4.	Prof. P. Karkuzhali. MD Prof., Instt. of Pathology, MMC, Ch-3	-- Member
5.	Prof. A. Radhakrishnan MD Prof of Internal Medicine, MMC, Ch-3	-- Member
6.	Prof. S. Deivanayagam MS Prof of Surgery, MMC, Ch-3	-- Member
7.	Thiru. S. Govindsamy. BABL	-- Lawyer
8.	Tmt. Arnold Soulina MA MSW	-- Social Scientist

We approve the proposal to be conducted in its presented form.

Sd/ Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.

R Nadini 22/2/13
Member Secretary, Ethics Committee

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